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Genetic Variation of Soybean Hybrid Populations by Natural Selection in Spring Crop Season at Four Locations[1]

I. Frequency Distributions for Certain Agronomic Characters in F_2 Generation

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Abstract: In spring crop season 1983, two F_2 soybean (*Glycine max*) hybrid populations, KS8×TN15 (Population A) and TN15×T175 (Population B) were planted in four locations of Taiwan for studying the frequency distributions and breeding parameters of eleven characters in F_2 populations. The distribution patterns showed late flowering in Tainan and Taichung locations, whereas those in Pingtung and Hsinchu flowered earlier. All characters studied distributed continuously but varied among locations. The standard deviations of plant height, nodes on main stem, days to flowering and days to maturity tended to be increased from south toward north. The results suggested that some differentiation in F_2 populations under various locations were involved.

Introduction

A hybrid population of self-pollinated crop advanced for several generations under varied environments would be a very useful way in the study of evolution, adaptation, breeding parameters, and genetic variation of the crop. Selection can be carried out in early generation and characters desired can be selected and individual plants enable fully to express their potential characteristics when hybrid populations are advanced under favorable environments [1,5,6,14]. Evidence showed that environmental effect on the characteristics of a bulk populations usually occurred [1]. The genetic parameters as correlation, heritablilty and inheritance mode may be significantly changed when hybrid populations of crops are subjected to natural selections [2,4,5,7,12,15,16,17,18,19]. Moreover, variable environments may influence selection efficiency [13,16,17,18] and create variant biotypes [6,7,8].

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Three crops of soybeans, namely spring, summer and fall (in southern-most that only) crop seasons can be adapted in Taiwan[9,10,11]. Significant association between crop season and variety consistently existed[12,17]. Invirtually, soybean breeding in Taiwan has totally done in two successive seasons each year——which is called the disruptive seasonal selection[13,18], but it has rarely done on direction seasonal selection. Significance on these two soybean breeding schemes under different planting seasons and locations is an urgent matter that must be solved soon as possible.

Soybean is rather sensitive to environmental factors. It grows island-wide in Taiwan. Though Taiwan is a tiny island, its weather differs greatly from north down south resulting from its long and narrow leaf-shaped geographic nature. Consequently, the planting time of soybeans varied with locations and the varieties adapted to particular areas are required. Therefore, to study the relationship between environment and soybean breeding in Taiwan is of great important event.

The main purpose of this experiment was to study the genetic variation and breeding parameters by growing two soybean hybrid populations from F_2 to F_5 generations at four locations and in two crop seasons (spring and fall) each year. We are in great hope that the result might suggest the most suitable soybean breeding locality and selection method in Taiwan. This paper reports the variation of frequency distributions of several agronomic characters in two F_2 soybean populations in spring crop season 1983 at four locations.

Materials and Methods

Two F_2 soybean populations, KS8×TN15 (Population A) and TN15×T175 (Population B), were grown during the spring season 1983. A total of 1,000 to 2,000 F_2 and 100 parental seeds were sown (1 seed per hill) respectively on March 1 at Kaohsiung District Agricultural Improvement Station (Kaohsiung DAIS), located in Pingtung, southernmost of Taiwan, on February 4 at Shanhua, Tainan, south-west of Taiwan, on March 1 at Taiwan Agricultural Research Institute (TARI), Taichung, middle-west of Taiwan, and on March 13 at Hsinchu (Taoyuan DAIS), northern part of Taiwan. Local cultural practice was adopted for the management of the experimental field work. Measurements were randomlg made from 500 F_2 and 50 parental plants for plant height, number of branches, nodes on main stem, pods of branches, pods on main stem, number fo seeds, days to flowering, days to maturity, seed weight, total pods, and 100-seed weight.

Experimental Results

F_2 distributions and means and standard errors for the eleven characters measured in populations A and B at four locations were shown in Figs. 1 to 11. A detailed description for each of them are as follows:

1. **Plant height** (Fig. 1)

The F_2 distribution for plant height are shown in Fig. 1. The continuously and transgressively segregations toward tall parents were found in four experimental locations. In population A, this character gave bimodal distributions in Tainan, Taichung

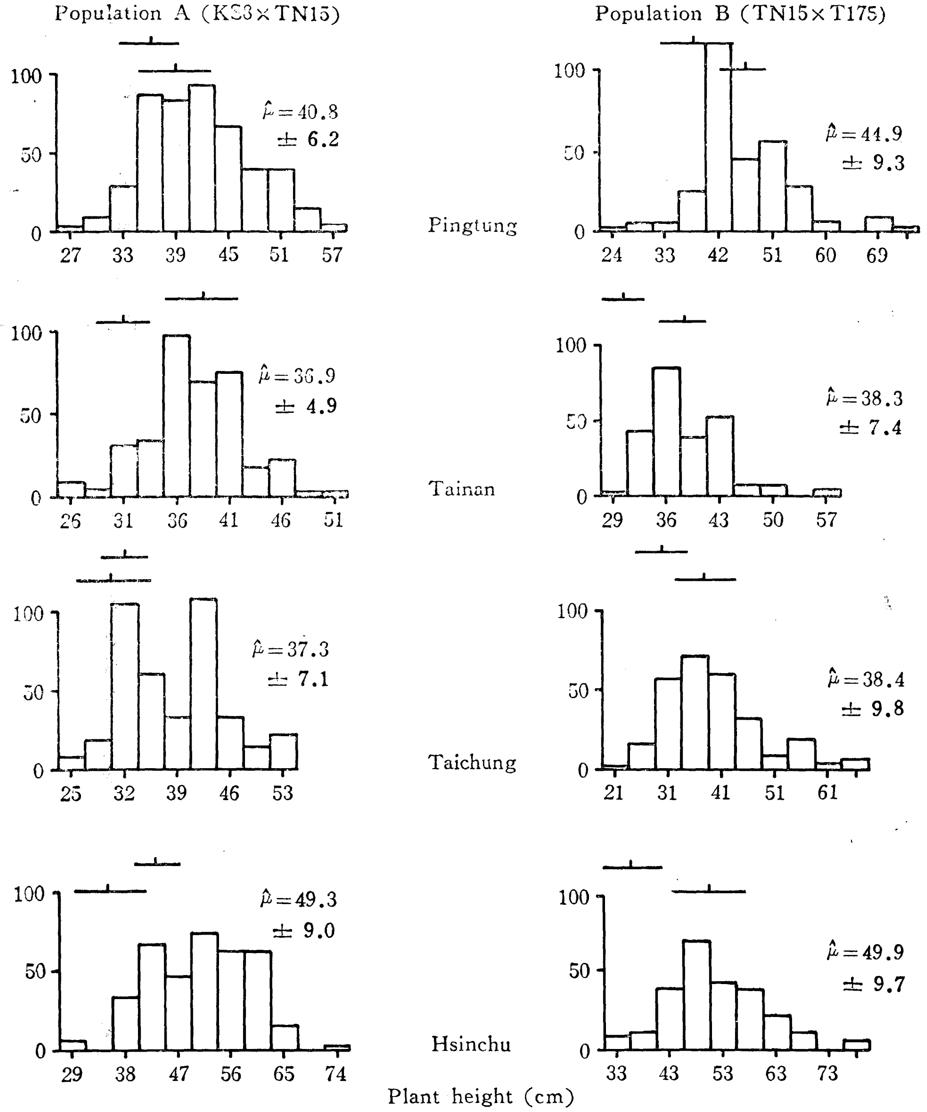

Fig. 1. F_2 distributions of plant height in four locations. Symbol (-+-) indicates the parental means with standard error.

and Hsinchu locations. The variability was larger in Hsinchu, moderate in Taichung, and smaller in Tainan. Complete dominance was showed in Pingtung, partial dominances in Tainan and Hsinchu, and over dominance in Taichung location resulting from their mean values were equal, intermediate and above to their parents.

Compared to population A, distribution patterns in population B showed wider variation and larger mean values in four locations. This character gave continuously and transgressively segregations in Pingtung and Taichung locations. Character of plant height showed a bimodal curve in Pingtung and Tainan, and a positive skewness distribution

in each of the four locations. Partial dominances were showed in four locations based on the mean values of plant height.

2. Number of branches (Fig. 2)

The F_2 distributoins with respect to branch number are shown in Fig. 2. Continuous and transgressive variations showed in four locations in population A. In addition, there was a positive skewness distribution in Hsinchu, and approximate-normal distributions in Pingtung, Tainan and Taichung locations. Dispersion for branch number were larger in Tainan and Hsinchu, and smaller in Taichung. The F_2 population means

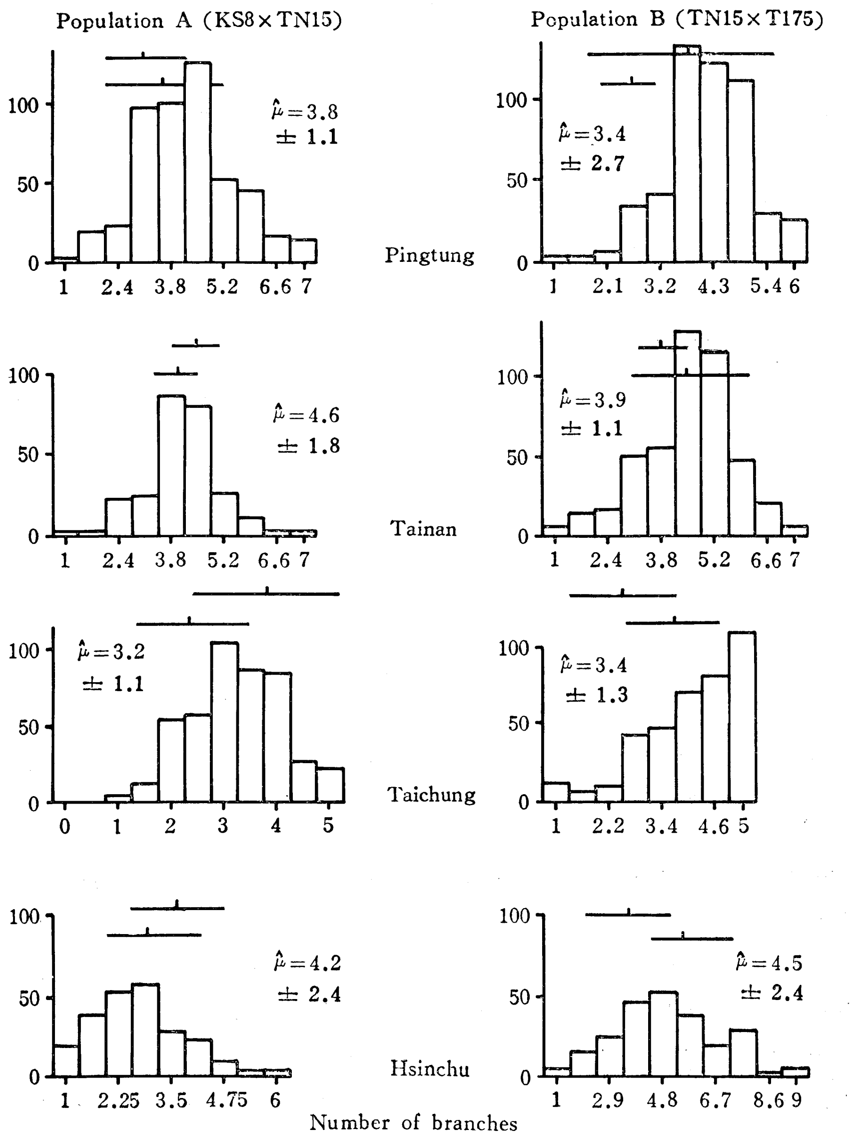

Fig. 2. F_2 distributions of branch number in four locations. Symbol (⊥) indicates the parental means with standard error.

showed over dominances in Pingtung, and partial dominance in Taichung and Hsinchu locations.

Continuous and transgressive distributions showed in Pingtung in population B. A negative skewness curve occurred in Taichung, and approximate-normal distributions in Tainan and Pingtung, and a bimodal curve in Hsinchu. This character gave wider distribution in Pingtung, Hsinchu, and narrow in Tainan. The F_2 population means indicated a quantitative type of inheritance with branch number being partial dominant in Pingtung, Tainan and Hsinchu, and over-dominant in Taichung.

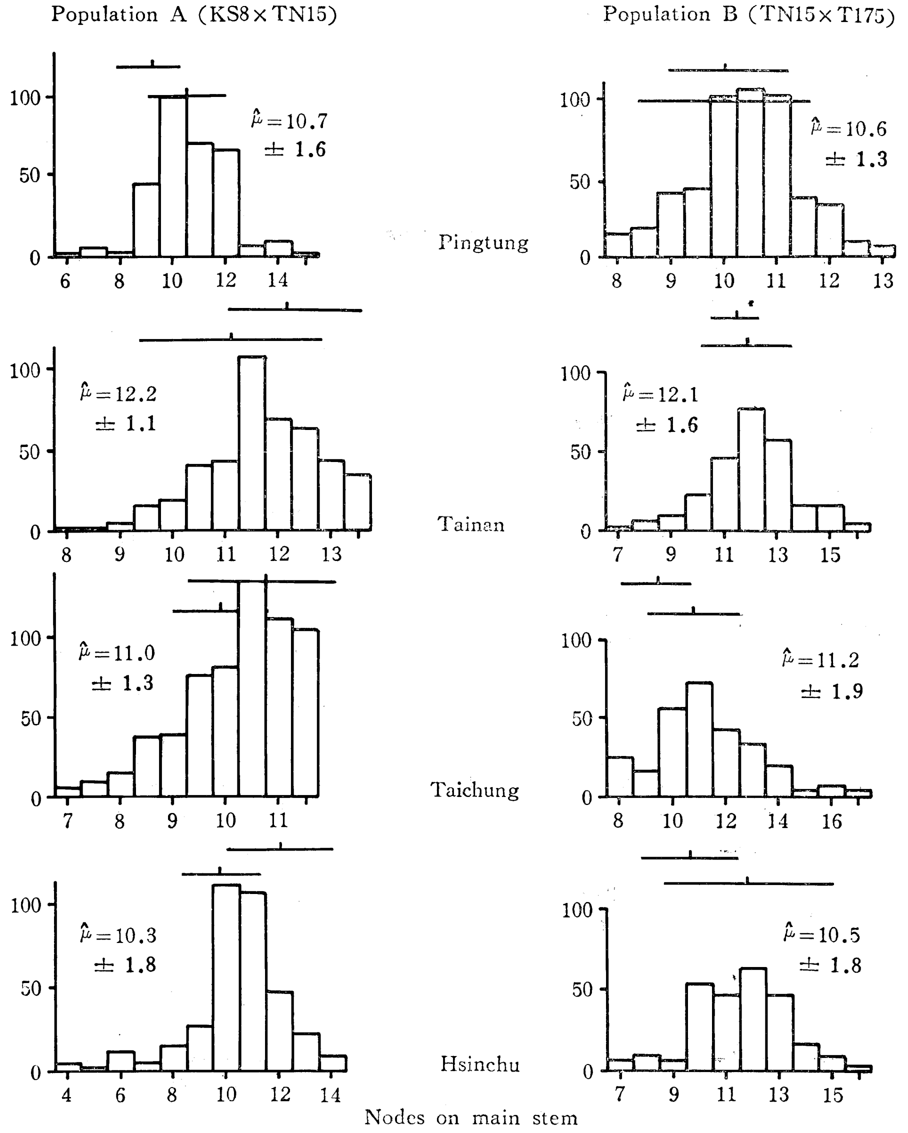

Fig. 3. F_2 distributions of nodes on main stem in four locations. Symbol (⊥) indicates the parental means with standard error.

3. Nodes on main stem (Fig. 3)

The F_2 populations showed continuously and transgressively segregation in node number with a unimodal curve in Pingtung location in population A. Negative skewness curve showed in Taichung. Its dispersion was larger in Hsinchu, smaller in Tainan. The F_2 mean values for node number showed that complete dominances were involved in Tainan. Similarity, continuous distributions showed in population B in all four locations. Except for Taichung, node number was not segregated transgressively in other three locations. The F_2 populations distributed approximately-normal in Pingtung

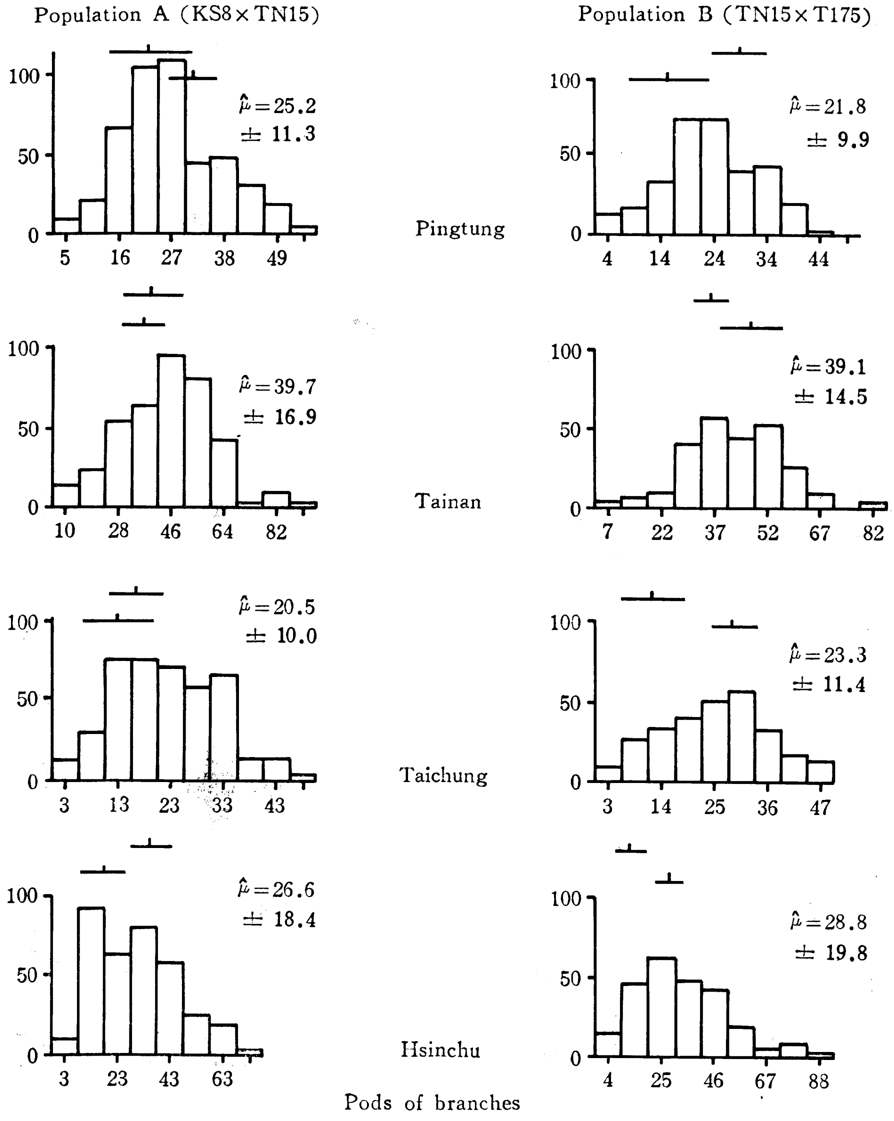

Fig. 4. F_2 distributions of pods of branches in four locations. Symbol (┴) indicates the parental means with standard error.

and Tainan, and a positive skewness curve in Taichung, a bimodal curve in Hsinchu. The F_2 population means showed that partial dominance for node number involved in Pingtung and Hsinchu locations. This character gave larger dispersion in Taichung, moderate in Hsinchu, and smaller in Pingtung.

4. **Pods of branches** (Fig. 4)

In population A, the F_2 populations were continuously and transgressively distributed with pods of branches in Tainan and Taichung locations, but no transgressive segregations in Hsinchu and Pingtung were observed. Fig. 4 showed that skewness curve toward more pods in Pingtung and Hsinchu, and toward less in Tainan were found. Larger dispersion showed in Hsinchu, moderate in Tainan and smaller in Taichung location. Incomplete dominances showed in Pingtung, Tainan and Hsinchu locations resulting from their mean values of this character.

Similarity, population B also distributed continuouosly. No transgressive segregations were found except in Hsinchu location. This character gave bimodal curve in Tainan, negative skewness in Taichung and positive skewness curve in Hsinchu. Incomplete dominance were found in all the four locations. This character dispersed largely in Hsinchu, moderately in Tainan, and small in Pingtung.

5. **Pods on main stem** (Fig. 5)

This character gave continuously and transgressively with positive skewness distributions in population A. Its dispersion was large in Hsinchu, moderate in Tainan, and small in Taichung. The means of F_2 populations showed complete dominance in Pingtung, over dominance in Taichung, and incomplete dominance in Tainan and Hsinchu locations.

In population B, continuous distributions also showed in four F_2 populations, but no transgressive segregations were found. This character had negative skewness curve in Pingtung, bimodal curve in Tainan. It dispersed largely in Tainan, moderately in Hsinchu, and small in Pingtung. The F_2 means were intermediate to their parents indicating incomplete dominance were involved except in Pingtung location.

6. **Number of seeds** (Fig. 6)

Continuous variable and transgressive segregations were showed in population A except in Pingtung where no transgressive segregation was found. This characted gave positive skewness curves in Pingtung and Hsinchu, and a bimodal curve in Taichung. The dispersion was large in Tainan, moderate in Pingtung, and small in Taichung location. Except in Pingtung the means of number of seeds in other three locations, Tainan, Taichung and Hsinchu showed overdominances for this character.

In population B, the frequency distribution showed continuously and transgressively only in Hsinchu location. This character gave positively skewness distributions in Tainan and Hsinchu locations, and appoximate-normal distribution in Pingtung. The dispersion was large in Hsinchu, mdoerate in Tainan, and small in Pingtung. The F_2 means showed that partial dominance in Pingtung, Tainan and Taichung locations.

7. **Days to flowering** (Fig. 7)

In population A, the distributions of days to flowering showed continoúosly in four

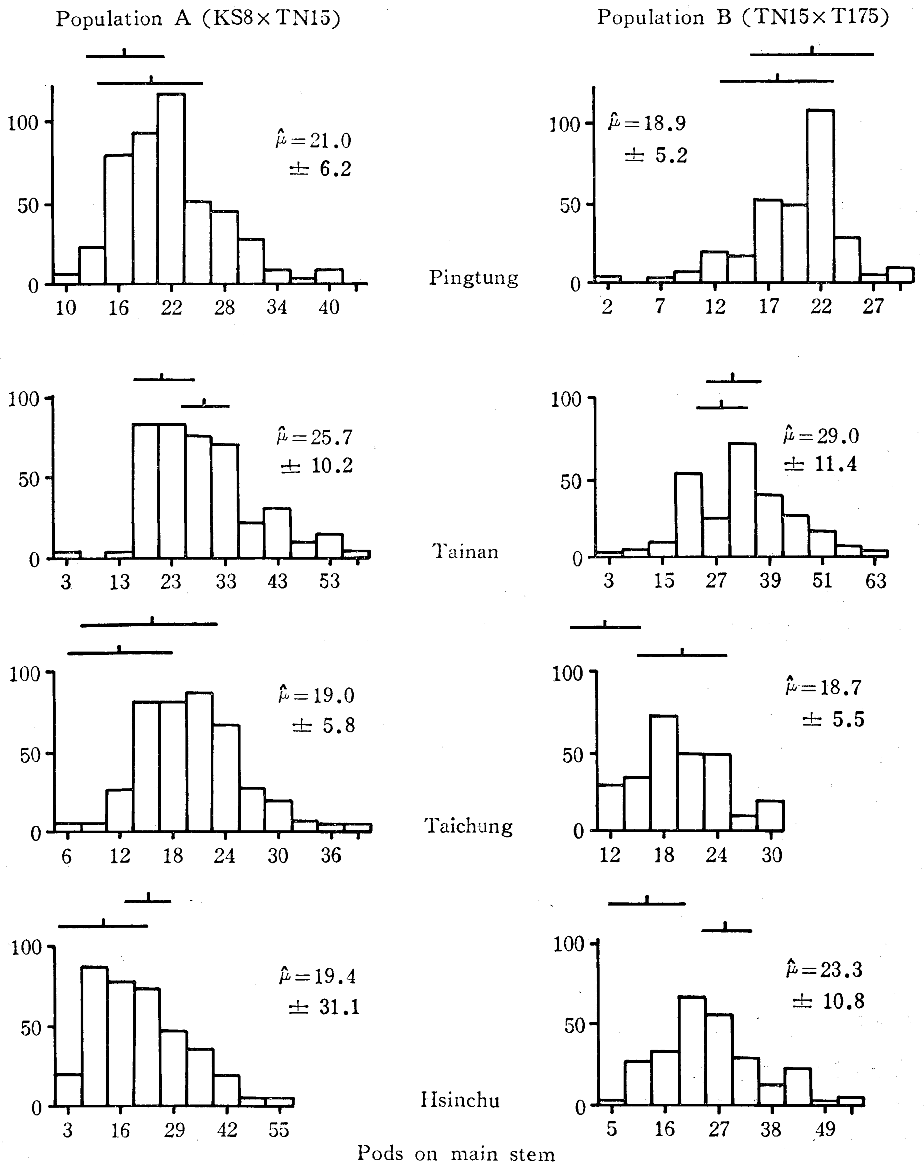

Fig. 5. F_2 distributions of pods on main stem in four locations. Symbol (┴) indicates the parental means with standard error.

locations. However, this character distributed transgressively only in Hsinchu location. It gave a multimodal curve in Tainan, and bimodal distributions in other three locations. It had larger dispersions in Tainan, moderate in Pingtung, and smaller in Hsinchu location. The F_2 population means showed that over dominance were involved for days to flowering in Pingtung, Taichung and Hsinchu locations.

F_2 distributions in population B were pretty much the same in population A. Its dispersion was larger in Tainan, smaller in Pingtung location. The mean values showed that overdominance was involved only in Tainan location.

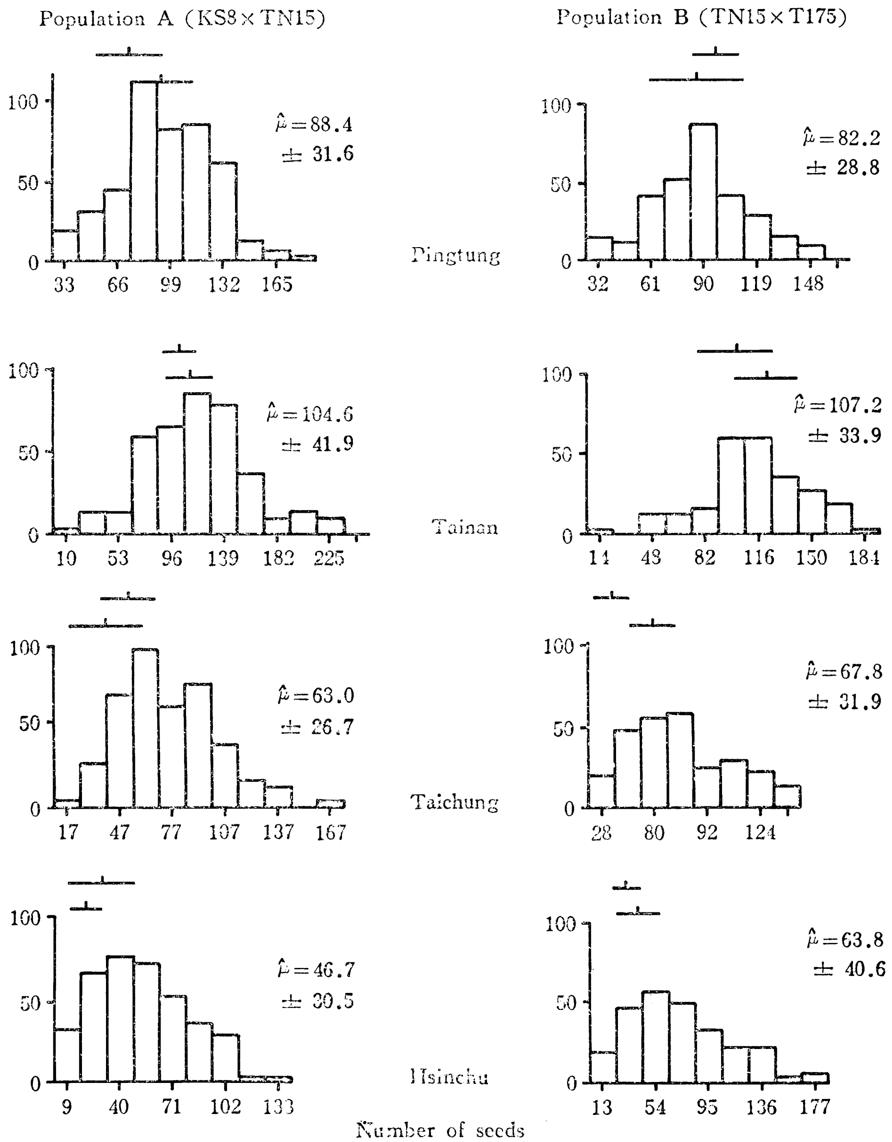

Fig. 6. F_2 distributions of number of seeds in four locations. Symbol (⊥) indicates the parental means with standard error.

8. Days to maturity (Fig. 8)

In population A, continuous and multimodal frequency distributions for days to maturity were found in four locations. Except in Hsinchu location, the segregations were positively skewed in other three locations. Population A gave larger dispersion in Hsinchu, moderate in Taichung, and smaller in Tainan. The distribution patterns in population B differed greatly with those in population A. Transgressive segregations and partial dominances for this character were showed in all four locations. The dispersion was larger in Hsinchu, moderate in Tainan, and smaller in Pingtung location.

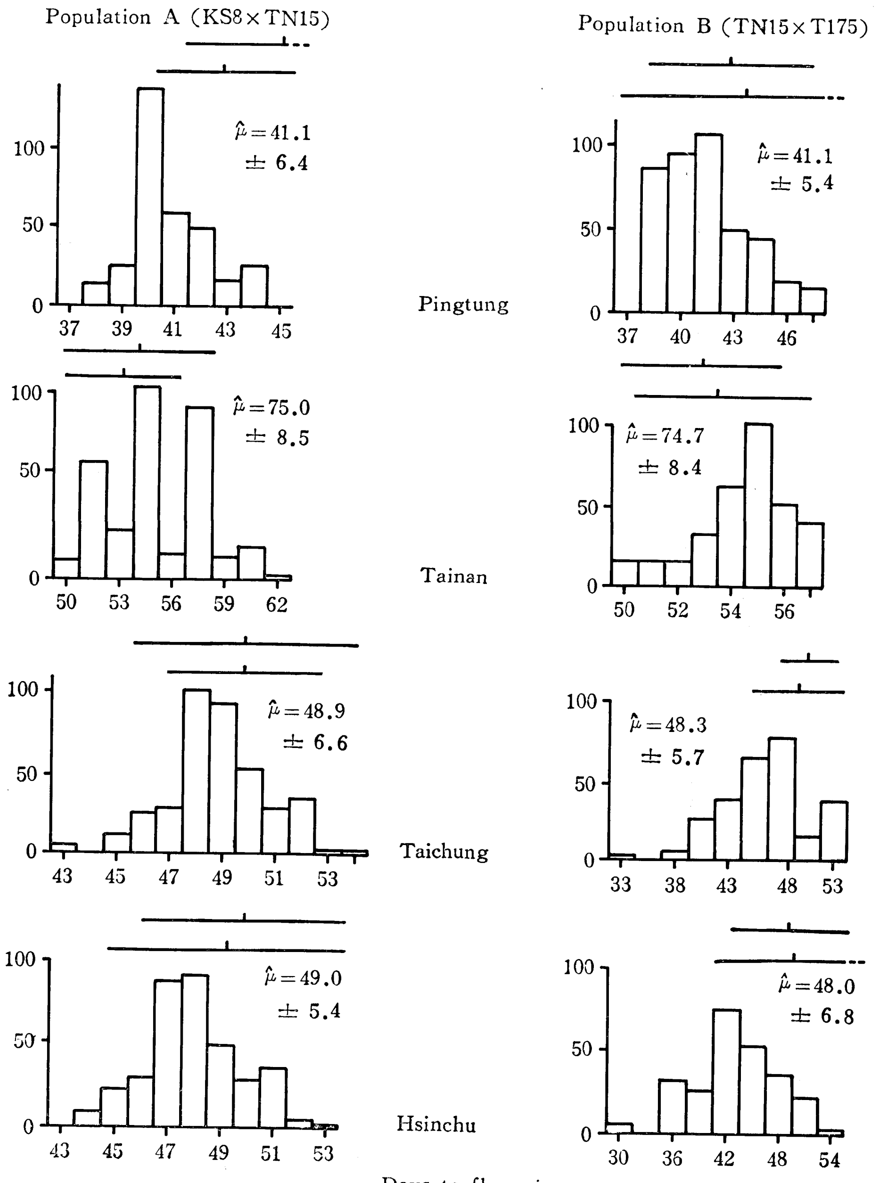

Fig. 7. F_2 distributions of days to flowering in four locations. Symbol (┴) indicates the parenal means with standard error.

9. Seed weight (Fig. 9)

The F_2 populations distributed continuously and transgressively in population A in four locations. The distribution curves were positively skewed in Taichung and Hsinchu locations. It gave larger dispersion in Taichung, moderate in Tainan and smaller in Hsinchu location. The F_2 means showed overdominant inheritance for this character in Taichung, and incomplete dominances in other three locations. Though this character

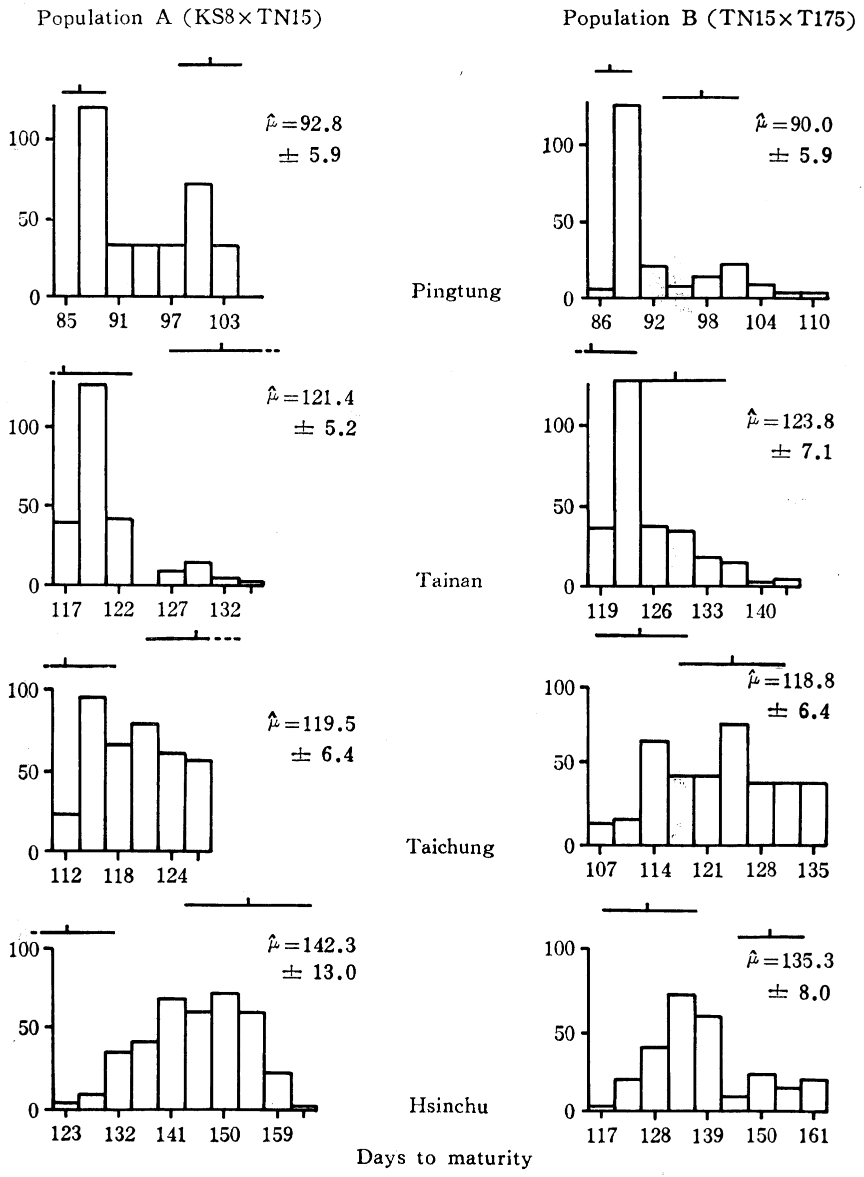

Fig. 8. F_2 distributions of days to maturity in four locations. Symbol (┴) indicates the parental means with standard error.

distributed continuously in population B in four locations, it distributed transgressively only in Hsinchu. And the distribution curves were positively skewed in Taichung and Hsinchu locations. Its dispersion was large in Hsinchu, moderate in Tainan, and small in Pingtung. The mean values of F_2 showed that incomplete dominances were involved in four locations.

10. Total Pods (Fing. 10)

In population A, continuous variable and transgressive segregation was found only in Taichung location. The F_2 populations showed approximate-normal distributions in

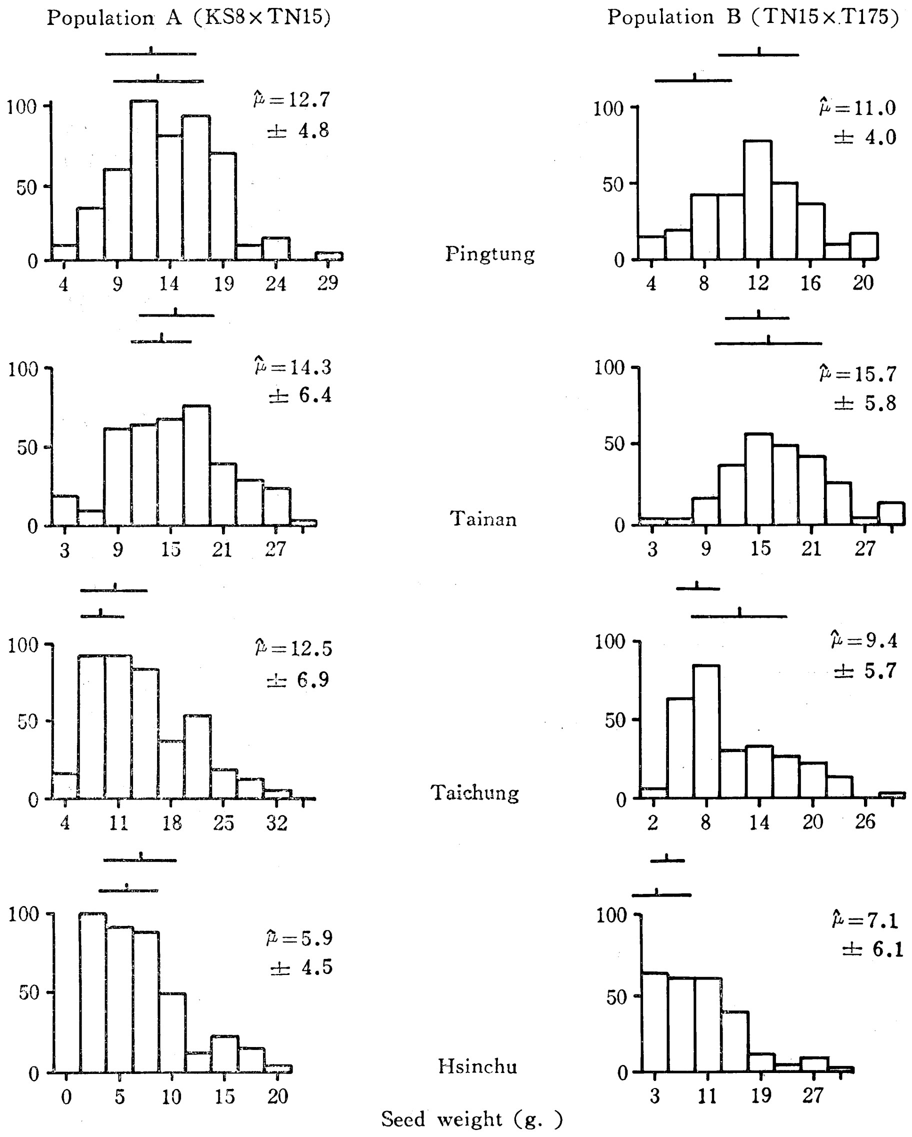

Fig. 9. F_2 distributions of seed weight in four locations. Symbol (⊥) indicates the parental means with standard error.

Pingtung and Tainan, and a positive skewed curve in Hsinchu. This character dispersed largely in Hsinchu and Tainan, and small in Taichung. The F_2 means showed that overdominance in Taichung and incomplete dominances in Pingtung and Tainan locations were found for this character.

Similar in dirtribution patterns were showed in population B. This character distributed approximately-normal in Pingtung and Tainan locations. Total pods gave larger dispersion in Hsinchu, moderate in Tainan, and small in Pingtung. The F_2 means

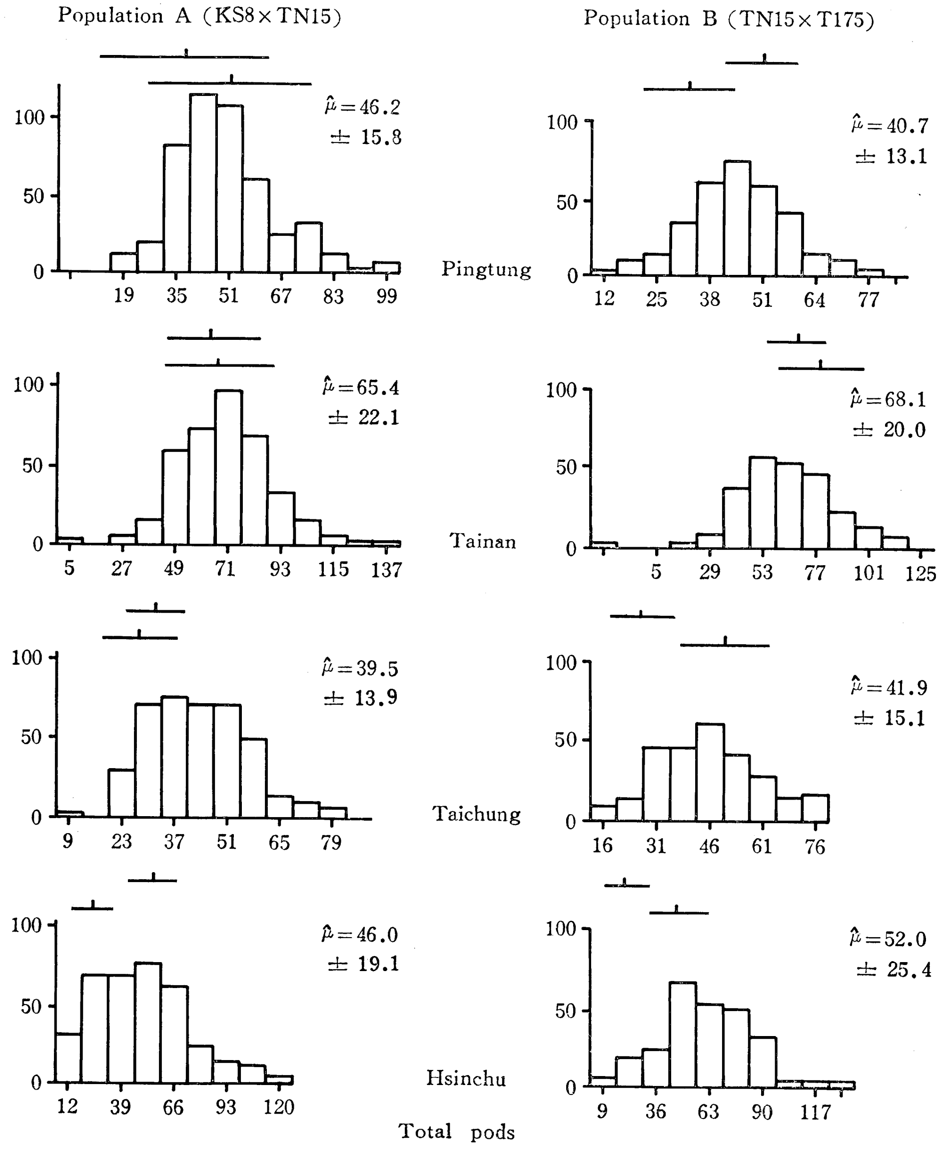

Fig. 10. F_2 distributions of total pods in four locations. Symbol (–⊥–) indicates the parental means with standard error.

indicated that partial dominances were involved in all four locations.

11. **100-seed weight** (Fig. 11)

F_2 populations in both populations showed continuously segregations in four locations. Except for Hsinchu location in population B, no transgressive distributions were found. This character distributed approximately-normal in Tainan and positively skewness in Pingtung location in population A. It gave larger dispersion in Hsinchu and Taichung, and smaller in Tainan.

In population B, this character distributed positively skewness in Pingtung and Ta-

ichung, and bimodal in Hsinchu location. Its dispersion was larger in Taichung, smaller in Pingtung. The F_2 mean values in both populations indicated that incomplete dominances were involved except for Tainan in population A.

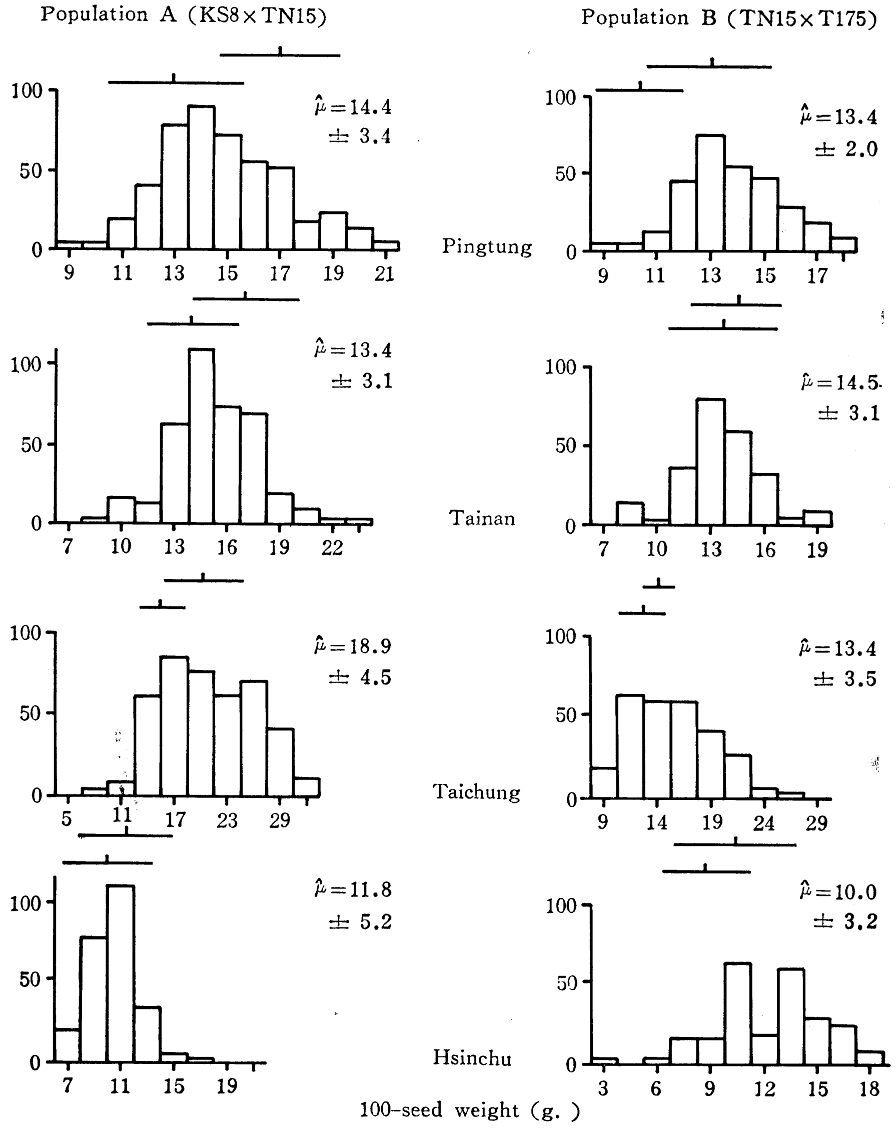

Fig. 11. F_2 distributions of 100-seed weight in four locations. Symbol (┴) indicates the parental means with standard error.

Discussion

The existance of genotype-environmental interaction is well known in crop plants. A genotype grown in diferent environments may cause different responses. Consequently, when a hybrid population was grown in different environments, inconsistent

phenotypes may appear owing to the interaction of genotype and environment. In other words, the change of environmental factors may vary the genotypes. Previous researchers [1,7,14] pointed out that a significant difference of hybrid population distribution patterns from various locations often occurred. Same trends of frequency distributions for certain characters were found in this experiment. The degree of genetic variability of each characters within the population is inversed in proportion to locations. Marked differences among distributions arose not ony in populations and agronomic characters, but also in locations tested. Of the four locations temperature was rather low in Hsinchu, northern part of Taiwan, during the early growing stage in spring season. However, temperature was rather high in Pingtung, southern part of Taiwan, at the same period. This indicates that geographic/local differences apparently existed in this study. Thus it is with the experiment results.

Several investigators [2,3,4,6] have pointed out that micro-differentiation may arise within the plant population due to the change of, even the minimal environmental factors. Therfore, the population variability observed can be considered the differentiation for each F_2 population under each environment force, or natural selection. In general, the plant population subjected to longer natural selection, the longer efficiency and more prominent results would appear. Futhermore, there is a close relationship among natural selection and correlation intensity and direction of the agronomic characters involved. More information will be obtained with the advancement of progeny generations added.

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春作單向及不同栽培地區之自然淘汰對大豆雜種集團育種行爲之影響[1]

I. F_2 世代農藝性狀頻度分布之變異

詹國連 李瑞興 曾富生[2]

摘 要

使用 KS8×TN15 (A集團) 及 TN15×T175 (B集團) 兩個大豆雜種集團之 F_2 種子，於1983年春作分別播種於臺灣四個地區，探討 F_2 集團之農藝性狀，在四個不同栽培地區之集團分布型及各種育種介量。

兩個 F_2 集團之分布型，在臺南及臺中地區偏向晚開花，在屏東及新竹偏於早開花。所有調查性狀均呈連續性之分離，且分布型在不同栽培地區間均有顯著差異。而株高、分枝數、主莖節數、開花期及成熟期等性狀之集團的分散度，一般呈現由南向北增大之趨勢。其他性狀也因地區有顯著差異。由此結果，可推測 F_2 雜種集團因不同栽培環境之影響，似乎地區間已有分化之現象。

1.臺灣省農業試驗所 研究報告第 1286 號。

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